Application/Control Number: 09/922,363

Art Unit: 2877

Attorney Docket No.: CM 080201

REMARKS

The Examiner rejected pending claims 1, 4-6, and 11-15 under 35 USC §103(a) as being unpatentable over U.S. Patent No. 5,923,422 to Keens *et al.* ("Keens"), in view of U.S. Patent No. 4,984,898 to Höfler *et al.* ("Höfler") and U.S. Patent No. 3,970,389 to Mendrin *et al.* ("Mendrin"). The primary reference, Keens, relates to use of signal processing techniques, especially the use of a new type of analog-to-digital converter, to gas laser spectrometers. The two secondary references are directed to interferometers designed to measure dimensions, not to spectrometers designed to measure spectra. This difference, at the time of time of this invention, was significant, because solid-state lasers, such as the one disclosed in the Höfler patent, while suitable for interferometric length measurements, could not meet the stability and calibration requirements of spectra measurement. The Applicant's disclosure is directed to the application of a tunable solid-state reference laser and a filter that overcome the stability and calibration problems experienced in spectrometer applications. The existence of this problem is seen in the Keens reference by the fact that, even

though HeNe gas lasers were expensive, power intensive, hot, bulky and short-lived by comparison to solid-state lasers, Keens continued to disclose a gas laser. See Keens, at Col. 5:38 ("laser **11**, generally a HeNe laser"). This continued reliance on gas lasers by Keens is in spite the fact that Höfler, which proposed solid-state lasers for interferometers, was issued ten years before Keens.

Moreover, Applicant is aware that, at the time of the filing of this application to the present day, such gas lasers continued to be used owing to their intrinsic stability and calibration with substantially greater accuracy compared to the solid-state lasers. By overcoming this problem and applying solid-state lasers to spectrometers, the Applicant's disclosure solves a long-standing problem in the art.

The problem was set out in Applicant's Specification:

> [0058] It would be very desirable to replace helium-neon lasers, which are typically used as frequency references for interferometry, with small efficient semiconductor lasers. The power savings are up to 20 watts per laser replaced. This is a very important issue for portable interferometers. The waste heat generated by gas lasers has been determined to adversely affect the performance of some

> spectrometers. **Unfortunately, for the most**

> **part, semiconductor lasers have a frequency stability on the order of parts per thousand, while the HeNe lasers have a frequency stability on the order of parts per million.** The use of a small and inexpensive etalon (typically a quartz plate) to determine the absolute frequency of a laser is disclosed...
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> . . .
>
> [0063] ... This approach is capable of holding or determining the laser position to at least 1/1000 of a fringe, if not 1/3000 of a fringe or better. This approach gives a solid-state laser comparable frequency stability performance to a HeNe. The only cost incurred for each additional unit is the etalon...

See U.S. Pub. No. 2002/97,402 at p. 6 (emphasis added).

Applicant's invention overcame the problem by combining a tunable solid-state reference laser with a filter. This combination is not taught or suggested by Keens, the primary reference directly related to spectrometer technology. The Examiner combined Keens with the older Höfler reference, which

employed a semiconductor laser in an interferometer designed to measure distances. Höfler did not suggest the use of tunable solid-state reference lasers for spectrometers. Moreover, there was no motivation to apply the semiconductor laser described in Höfler, because from the time of its issuance to the filing of the present application, solid-state reference lasers were incapable of achieving the stability and calibration accuracy of gas lasers. Moreover, Höfler did not suggest the use of a filter in combination with a tunable solid-state reference laser in order to solve the stability and calibration difficulties. To fill this technological gap, the Examiner went further back to the Mendrin reference, a 1974 application, which disclosed the use of a "monochromator" with a "tunable dye laser" (<u>see</u> Mendrin, at Col. 9:8) to select an emission band. <u>Id.</u>, at Col. 15:6-14. However, Mendrin's dye laser of 1974 was a refrigerator-sized beast that had to be pumped continuously with cooled dye solution and a gas laser and tuned with prisms, gratings and other laser techniques of this era. <u>Id.</u>, at Col. 15:43-51. The technology associated with such primitive dye lasers is not obviously transferable to persons of ordinary

skill in the art of modern solid-state lasers. Moreover, the monochromator of Mendrin was used to select an emission band, whereas the filter used with the tunable solid-state laser of the present invention is used as a calibration standard to calibrate the solid-state laser independent of the spectrometer itself.

At this stage, a review of the three references will help show that they are not combinable in the way suggested by the Examiner. Keens, which was filed in 1998 claiming priority of a 1997 German application, disclosed a new method of signal processing, generally relating to the use of mass-produced high-resolution analog-to-digital converters. See Keens, at Col. 3:3-7 (outlining the steps for the "signal processing elements"). The "highly abstract" FT spectrometer geometry (see Keens, at Col. 5:22-23) shown by Keens in Figure 1, and relied upon by the Examiner, is a diagram of a typical spectrometer of the time, but it does not illustrate the substance of Keen's signal processing invention. With regard to signal processing, Keens builds on Brault's work (id., at Col. 5:44-49), which also related to signal processing, as noted in the present

application. See U.S. Pub. No. 2002/97,402, ¶ 0039, at p. 4.

Insofar as Figure 1 of Keens illustrates a typical spectrometer, the Examiner admits that Keens did "not teach a tunable solid-state reference laser source coupled to the spectrometer through a filter." See 5/3/04 OA, at p. 3. In fact, Keens specifically stated that "a HeNe laser supplies light to the interferometer for recording a reference interferogram." See Keens, at Col. 5:37-38.

The Examiner combined the Keens reference with Höfler, a 1988 PCT application claiming priority from a 1987 German application, in order to substitute the gas laser of Keens's spectrometer with the semiconductor interferometer laser of Höfler. Höfler discloses a "semiconductor laser **1** for interferometric measurement of geometric dimensions". See Höfler, at 2:41-42, see also at Col.1:45 ("laser interferometer for linear measurement"). Höfler does not disclose a "*tunable* solid-state laser", as stated by the Examiner (see 5/3/04 OA, at p. 4, emphasis added). The substance of Höfler's patent is the use of a semiconductor laser to compensate for a change in the refractive index of the medium in which distance is being

measured. See Höfler, at Col. 1:66-2:3. It must be emphasized that Höfler relates to interferometers intended "for interferometric measurement of geometric dimensions" (id., at Col. 2:41-42), and there is no claim made by Höfler indicating that the accuracy of such measurements achieves the part per million accuracy level that is understood to be the standard of interferometric spectrometry. Höfler does not suggest the use of semiconductor lasers as reference lasers in spectrometers, where the higher level of stability and calibration are needed. At the time of the Höfler patent, as well as later, at the time of the Keens patent and the invention here, the use of tunable solid-state reference lasers was not possible, owing to their inferior stability and calibration characteristics when compared to conventional HeNe lasers. Finally, Höfler did not disclose the use of filters to overcome this problem.

The Examiner combined a third reference, Mendrin, older than the other two, to add the filter element. See 5/3/04 OA, at p. 4. Mendrin was filed in 1974. Mendrin teaches the use of a "tunable dye laser" (see Mendrin, at Col. 9:8) for obtaining optical measurements of distance by interferometry. Id., at Col

1:5-6. Mendrin does not teach a particular level of accuracy for the laser nor the measurements achieved. Persons of ordinary skill in the art at the time of the present invention understand that the accuracy of the Mendrin interferometer is insufficient for the typical practice of spectrometry, which requires part per million accuracy. Moreover, the "dye lasers" of 1974 were cumbersome, refrigerator-sized devices that required continuous pumping of cooled dye solution with gas lasers and tuning with prisms and gratings. Id., at Col. 15:44-51 (citing several dye laser patents). Mendrin uses a "monochromator" in tandem with the dye laser. Id., at Col. 9:8-9. Mendrin's monochromator was used to select an emission band for the laser with "an effectively monochromatic frequency". Id., at Col. 9:17-22. Mendrin did not teach or suggest the use of a filter as a calibration standard, as claimed here. Nor did Mendrin teach or suggest the use of a reference laser or a filter to calibrate it independent of a spectrometer itself, as taught by the Applicant here. Obviously, Mendrin did not teach or suggest the use of a tunable solid-state reference laser. The emission band monochromator and dye laser pumping and tuning

systems of Mendrin are not obviously applicable to the solid-state reference laser taught by the Applicant and a person of ordinary skill in the art would not have been able to apply the teaching of Mendrin to either Keens or Höfler without taking extraordinary steps.

But, following the Examiner's line or argument, it would have been obvious to one of ordinary skill in the art as early as 1974, at the time Mendrin's patent issued, or 1988, at the time that Höfler's patent issued, to substitute a tunable solid-state reference laser with or without a filter, for the HeNe laser that has been used almost exclusively for interferometric measurements up to the present day, 16 to 30 years later. The vast majority of interferometric spectrometers sold in the year 2004 employed HeNe reference lasers, with their high power consumption, prodigious waste heat, relatively short lifespan and large size. Hence, even this year, the myriad advantages of solid-state lasers have not allowed widespread exploitation in the area of spectrometry of the teachings of Mendrin and Höfler from 1974 and 1988, respectively.

Moreover, the Examiner's assumption, that it would have

been obvious to one skilled in the art to substitute a solid-state reference laser for a gas reference laser, is factually incorrect. At the time of the instant invention, diode lasers were not known in the field of interferometric spectrometry. No reference to diode lasers can be found in any of the relevant textbooks. See, *e.g.*, Griffiths, Beer, Brault. Even to the present day, almost all interferometric spectrometers continue to use Helium-Neon lasers as optical path difference references, in spite of the disadvantages of cost, heat generation, power dissipation and size. This fact strongly indicates that it is not obvious to substitute a tunable, solid-state reference laser in place of a conventional gas laser. The principal reason that it is not obvious to use a diode laser is that these devices are notorious for their drift with wavelength. Further, it is not obvious how to control the wavelength of a diode laser that is to be used in an interferometric spectrometer to achieve stabilities on the order of part per million. The present application teaches a novel approach to measuring the wavelength of the laser with great accuracy by exploiting the tuning capability of the diode laser.

As set forth in MPEP 2141.01 III, when denying a claim based on obviousness, an examiner cannot view prior art references with the wisdom of hindsight vision afforded by the claimed invention. Instead, the examiner must cast her or his "mind back to the time of the invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field... Close adherence to this methodology is especially important in cases where the very ease with which the invention can be understood may prompt one to fall victim to the insidious effect of a hindsight syndrome wherein that which only the invention taught is used against its teacher." (Citations and quotations omitted.) In <u>In re Werner Kotzab</u>, 217 F.3d 1365, 1369-71 (Fed. Cir. 2000), the Federal Circuit explained this prohibition of hindsight reconstruction:

> While the test for establishing an implicit teaching, motivation, or suggestion is what the combination of these two statements of Evans would have suggested to those of ordinary skill in the art, the two

> statements cannot be viewed in the abstract. Rather, they must be considered in the context of the teaching of the entire reference. Further, a rejection cannot be predicated on the mere identification in Evans of individual components of claimed limitations. Rather, particular findings must be made as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed").

The Examiner argued that Mendrins' emission band teaching rendered obvious the stabilization and calibration teachings of the present invention. See 5/3/04 OA, at pp. 4-5. The Applicant respectfully disagrees, and points out that the Mendrin's reference does not provide guidance for the technology involved in the present invention.

With respect to claim 4, the Examiner argued that Mendrin teaches an etalon. See 5/3/04 OA, at p. 5. In response, as

argued above, the emission band monochromator of Mendrin has no application to Applicant's tunable solid-state reference laser and filter, which is directed toward the stabilization and calibration of solid-state laser independent of the spectrometer rather than being used to adjust the coherence length of a dye laser as Mendrin teaches.

The Examiner also rejected claim 5 on the ground that vertical cavity surface emitting lasers ("VCSEL") are well known solid-state lasers and it would have been obvious to one of ordinary skill in the art to substitute a VCSEL in order to achieve compactness. See 5/3/04 OA, at p. 5. The Applicant respectfully disagrees. At the time of the invention herein, VCSELs were not used in spectrometry, with or without filters, with the control, data acquisition and processing system disclosed in this application. As noted in the specification, and discussed above, prior art spectrometers did not use or suggest the use of solid-state lasers as reference lasers.

With respect to claim 6, the Examiner argued that, while neither Mendrin nor Höfler teach a specific bandwidth for the tunable solid-state laser disclosed here, it would have been

obvious to one of ordinary skill at the time of the invention to select a specific bandwidth so as to provide for a highly accurate mirror position measurement. See 5/3/04 OA, at p. 5. Solid state lasers with such bandwidths were generally not available and were invented for an entirely different industry. In this rejection, the Examiner improperly is using the Applicant's own explanation as support for the obviousness rejection.

The Examiner rejected claim 11 on the ground that Mendrin, Höfler and Keens all teach signal demodulation for determining distance measurements. See 5/3/04 OA, at p. 5. The usual practice for processing the reference laser signal in a Fourier transform spectrometer is to detect the times of the zero crossings and then to acquire the infrared signal at these times. In the conventional approach, the zero crossings are converted to digital pulses which are used to trigger the analog-to-digital converter. As discussed in the applicant's specification, Brault and others have taught the approach of digitizing the infrared channel with a clocked analog-to-digital converter, while simultaneously recording information about the

times of the zero crossings. Neither of these approaches to processing involve demodulation, nor is demodulation of the reference laser signal taught in any of the textbooks on the subject of Fourier transform spectrometry. Nor is demodulation taught in the practice of Fourier transform spectrometry as a method for monitoring, controlling or correcting a diode laser wavelength. Therefore, the Applicant respectfully disagrees with the Examiner's argument and responds that the prior art did not teach the demodulation of reference signals.

With respect to claims 12, 13 and 15, the Examiner argued that Keens teaches transfer functions for the detector, adaptive filters and an additional source of radiant energy, as well as teaching the accounting for non-linear responses. See 5/3/04 OA, at p. 5, *citing* columns 6, 7 and 8. The Applicant respectfully agrees with the Examiner's reading of the cited passages of Keens. The use of light sources to probe the transfer function of detectors has, to the knowledge of the inventor, appeared only once in the prior art, in the context of a laboratory set up for testing detectors. In that case, Brasunas described the use of modulation frequencies up to 100

Hertz, generated by the use of LED's. There was no hint in that paper or any other prior art of the possibility of making these components to function as an integral part of a spectrometer to effect an internal calibration. Brasunas did not teach the fact that light emitting diodes could produce modulation frequencies that would be useful to the upper limits of the modulation frequencies employed in Fourier transform spectrometers. Therefore, the technique of using light emitting diodes and other light sources to probe detector transfer functions are not found in Keens or the prior art. Nor are these techniques taught in any of the textbooks on the subject of Fourier transform spectrometry, nor in the patent literature.

The Examiner rejected claim 14 on the ground that Keens teaches detecting an optically subtracted beam. See 5/3/04, at p. 5, *citing* columns 6, 7 and 8. The Applicant respectfully disagrees. Keens does not teach the use of an optically subtracted signal, as disclosed in the present invention.

1. **CONCLUSION**

In view of the above remarks, the Applicant respectfully requests reconsideration of the claims as amended and allowance

of same.

November 3, 2004

Respectfully submitted,

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